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Marketing Research Report No. 578

Dehydrofrozen Apple Slices

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CURRENT SERVICE RECORDS

Their Potential in Selected Markets

U. S. DEPARTMENT OF AGRICULTURE
Economic Research Service
Marketing Economics Division

PREFACE

This report is designed to provide producers, processors, distributors, and other interested persons with facts concerning the market potential for dehydrofrozen apple slices in institutional outlets. The study is part of a broad program of continuing research aimed at expanding markets for farm products. Determination of the acceptability of products in various forms--particularly newly developed products--and of ways to reduce marketing costs can provide a guide to industry in the development of new markets or the expansion of present ones.

The Economic Research Service conducted the research, with the assistance of the William E. McIntosh Company, Geneva, New York, and the Waterman Fruit Products Company, Ontario Center, New York, processors of the test product.

Personnel of the Western Utilization Research and Development Division, Agricultural Research Service, Albany, Calif., where the dehydrofrozen apple slices were originally developed, provided technical assistance in the planning and execution of the product tests.

The project was under the general supervision of Philip B. Dwoskin of the Market Potentials Branch, Economic Research Service.

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HIGHLIGHTS

A study of bakers' acceptance of dehydrofrozen apple slices was conducted to determine their adaptability to preparation procedures used in bakeries. These apple slices are prepared by dehydrating fresh apples to about 50 percent of their original weight and then freezing them in the same manner as apple slices that have not been partially dehydrated. Dehydrofrozen apple slices require only about half the space needed for an equivalent amount of regularly frozen slices. These reductions in volume and weight result in substantial savings in freezing, packaging, transportation, storage, and other handling and distribution costs.

Product tests in this study were conducted among bakers in three cities: Baltimore, Md., Philadelphia, Pa., and Washington, D. C., during 1960 and 1961. Each of 88 cooperating bakers was furnished with a supply of the test product roughly approximating his average weekly usage of apples. After the bakers had an opportunity to use the apples, they were interviewed to learn of their experiences in preparing them for pie baking.

Approximately 9 out of 10 respondents indicated that there were advantages to using dehydrofrozen apple slices. The majority of the advantages cited by the bakers dealt with convenience and quality. In spite of the fact that dehydrofrozen apples require the additional step of reconstitution, respondents considered convenience to be the most important advantage.

Conversely, cooperators who had difficulty in preparing dehydrofrozen apple slices cited as many as 4 disadvantages, but the majority mentioned only one--the time and labor required to prepare them for pie baking.

Most of the bakers commented on differences in the appearance of products made with dehydrofrozen apples and those made with their usual apple stock. Most of these comments were favorable to the test product.

About 4 in 10 bakers considered the test product to be "excellent" and had no suggestions for improvement. The remainder had suggestions to improve the marketability of the product. These suggestions included printing the instructions, variety of apple, size of slice, and other information on the outer surface of the package shell.

Eighty-five percent of the respondents found the 15-pound package of dehydrofrozen apple slices to be satisfactory in their baking operations. This is because the reconstituted amount of 30 pounds equals the amount of regularly frozen apple slices that they usually purchased in one unit.

Conservation of storage space in the freezer was found to be one of the specific advantages of the test product. Compared with conventionally frozen apples, they require about 50 percent less freezer space, and, because the median amount of freezer space available to small and medium-sized bakeries included in the sample was only 135 cubic feet, this saving is important.

The generally favorable reactions of the bakers cooperating in the study, especially those using large quantities of apple slices in their baking operations, indicate that the dehydrofrozen product has excellent growth possibilities in this industry.

DEHYDROFROZEN APPLE SLICES: THEIR POTENTIAL IN SELECTED MARKETS

By Edward J. McGrath and Howard W. Kerr, Jr. agricultural economists
Marketing Economics Division
Economic Research Service

INTRODUCTION

Objective

The purpose of the study was to obtain information on (1) problems institutional users have in using dehydrofrozen apples, with particular reference to how the product fits into production proceedings; and (2) relationships between the new product and the usual product used.

Background

Consumption of fresh and processed apples on a fresh equivalent basis declined from 35 pounds per capita in 1935 to about 26 pounds in 1961 (fig. 1).

In the past 25 years (1935-59) the consumption of fresh unprocessed apples has declined from 70 to 60 percent of the annual crop, while the consumption of processed apples has increased proportionately. ^{1/} Similarly, the consumption of other fresh deciduous fruits has declined while consumption of processed forms has increased. Yet, today, only about 35 percent of the apple crop is processed, indicating that apples, as well as other deciduous fruits, have a long way to go before approaching the success achieved by the citrus industry through the innovation of frozen concentrated citrus juices.

In developing new fruit and vegetable products at the Western Utilization Research and Development Division of the Agricultural Research Service, it has long been recognized by researchers that many dehydrated fruits and vegetables do not recover their fresh texture when reconstituted. With some products, irreversible changes take place when they are air-dried to the low moisture level necessary for preservation. On the other hand, developments in dehydration processes have resulted in many highly acceptable products such as potato and sweetpotato flakes and granules, tomato and fruit powders and crystals, and dehydrated onions, garlic, and other seasonings.

The suggestion was made that certain fruits and vegetables might be dehydrated under controlled conditions only to the point where quality is not adversely affected--thus gaining important weight and volume savings--and then might be preserved by freezing. This combination of processes was called "dehydrofreezing." ^{2/}

^{1/} United States Department of Agriculture. Agricultural Statistics, 1957 and 1961.

^{2/} U. S. Patent No. 2,477,605 was issued on August 2, 1949, to Louis B. Howard, William D. Ramage, and Clyde L. Rasmussen, assignors to the United States of America as represented by the Secretary of Agriculture.

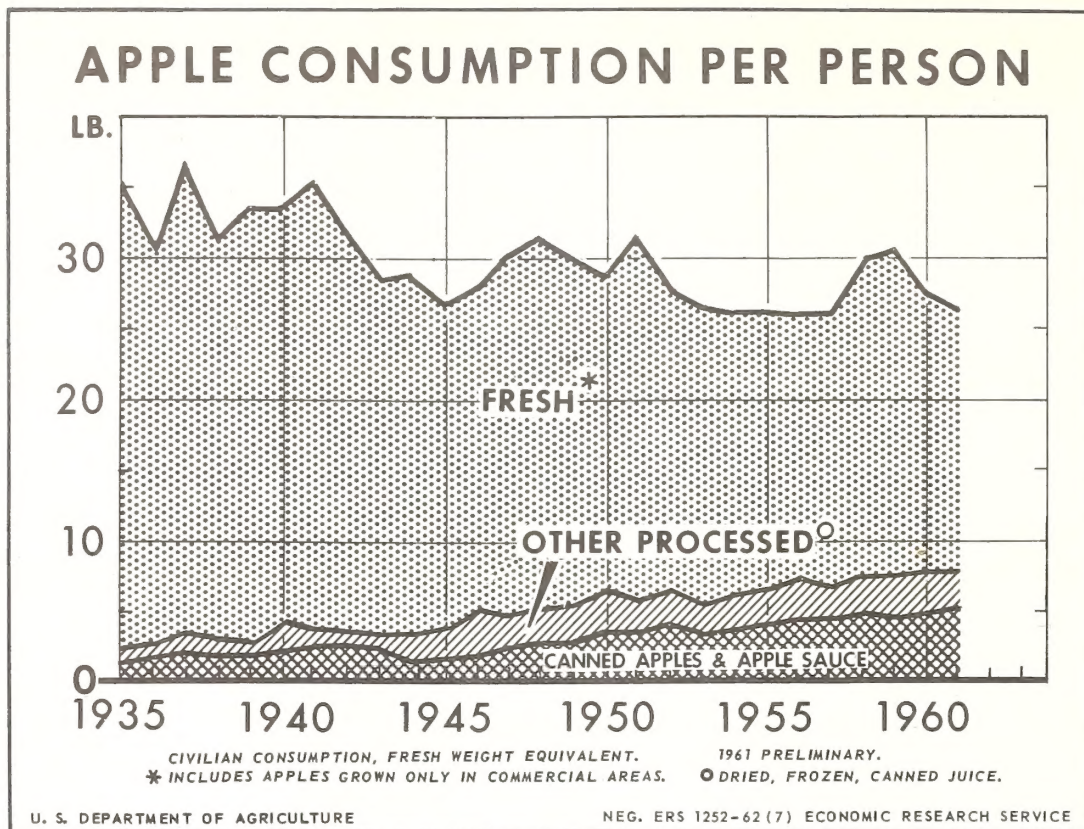


Figure 1

Dehydration to 50 percent of weight does not adversely affect quality of many fruits and vegetables. Dehydration much past this point often brings about undesirable changes in texture and results in products that do not reconstitute properly.

A considerable amount of water is evaporated in dehydrofreezing, but the resulting products still have a relatively high moisture content. Fresh apples, for example, contain about 85 to 90 percent water. Because the 50 percent of the fresh weight removed is all water, the dehydrofreezing process removes about 56 to 59 percent of the original water in the apple. The water content is thereby reduced from about 85 to 90 percent of the fresh weight to about 70 to 80 percent of the partially dried weight. Ordinary dried apples, on the other hand, contain approximately 15 to 25 percent moisture.

Dehydrofrozen fruits and vegetables retain quality comparable to those that are frozen in the usual way. In addition, partial dehydration imparts certain additional advantages. Frozen fruits, particularly those frozen with sugar, drip or bleed when thawed. This is avoided or reduced in dehydrofreezing. As an ingredient in manufactured food products, partially dried fruits and vegetables are useful in controlling moisture content.

Fruits and vegetables which can be dehydrofrozen successfully have certain advantages over other processed products: (1) They have less weight and bulk; (2) there is little or no drip upon thawing; (3) they provide better moisture control when they are used in manufacturing food products; and (4) they rehydrate more easily and completely and have better flavor, texture, and color than dehydrated products.

Many fruits and vegetables can be better preserved by freezing, in most important respects, than by any other known method. Because dehydrofrozen products compare favorable in quality with frozen products, they have the same commercial appeal. Another asset is that they incorporate some of the economic advantages of dehydrated products.

A number of fruits and vegetables have been developed into dehydrofrozen products by the Western Utilization Research and Development Division. Among these are peas, carrots, apples, cherries, apricots and pimientos. A product test of dehydrofrozen peas was conducted in 100 Milwaukee, Wis., restaurants in 1956-57. ^{3/} Results of the study indicated that this product possesses excellent commercial possibilities. Dehydrofrozen peas are now in commercial production. This product has been tested and accepted by the Army and Air Force menu boards and is currently being purchased in large quantities by the U. S. Army Quartermaster Corps. Large quantities are also being used by soup manufacturers. Dehydrofrozen pimientos have been used in the manufacture of processed cheese where moisture control is important.

Dehydrofrozen apple slices have been commercially available in limited amounts to the baking industry, and have met with varied success. Because of the success of other dehydrofrozen products, it was felt that a full-scale appraisal of the market possibilities of dehydrofrozen apple slices in an important commercial outlet such as the baking industry would be useful in predicting their commercial growth. To make this appraisal, information was needed on the size of specific potential markets; methods of handling, including pricing policies, transportation, and size of container. Dehydrofrozen apple slices were tested in three Eastern cities to get more information as to the acceptance of this product.

The impact of this new form and method of processing should be of great importance to the fruit processing and distributing industries, since widespread commercialization could result in substantial savings in containers, shipping, storage, and handling costs.

The Test Cities and Methodology

The tests were conducted in Baltimore, Md., Philadelphia, Pa., and Washington, D. C. These cities were selected because they have populations large enough to support commercial bakeries of all types, using all forms of apples; and are representative of a wide range of income and nationality groups. Also, a few bakers in these markets were users of dehydrofrozen apple slices. One of the commercial processors of dehydrofrozen apples was currently delivering apple products to each of the cities. Terminal refrigeration facilities were already available in these cities.

The study was conducted in two phases. In the first phase bakers in each of the test cities were selected and personal interviews were conducted to determine the bakery's characteristics. A supply of the test product was provided all participating bakers in the second phase. This was followed by a second personal interview to obtain the baker's observations and experiences with the product.

^{3/} McGrath, E. J. and Sills, M. W. Restaurant Acceptance of Dehydrofrozen Peas. U. S. Dept. Agr. Mktg. Res. Rpt. 198. Oct. 1957.

Phase I

During the summer of 1960, all bakeries listed in the telephone directory of each city were telephoned to determine whether or not they prepared their own apple pies. Of the firms contacted, 397 prepared their own apple pies. At random, 208 of these firms were selected to participate in this initial phase of the study. The managers of these firms were interviewed and data were obtained regarding each bakery's general characteristics. Also, in the second phase of the study the management was asked to test the dehydrofrozen apple product.

Of the 208 firms interviewed in Phase I, 165 agreed to cooperate in Phase II of the study. Because the supply of dehydrofrozen apples available for the study was limited to 7,500 pounds, or 15,000 pounds on a reconstituted basis, it was decided that more reliable results could be obtained by having fewer firms use the product over a longer period than to have a larger number prepare the dehydrofrozen apples only once. For this reason, 88 of the original 165 cooperating firms were selected, again at random, to participate in the tests. A size distribution of these firms appears in table 1.

Table 1.--Location and size of 88 bakeries included in 3 test cities

City	Size of bakery				Total
	Small	Medium	Large	Extra large	
	Number	Number	Number	Number	Number
Baltimore, Md.	9	11	4	3	27
Philadelphia, Pa.	8	25	5	2	40
Washington, D. C.	6	11	0	4	21
Total.....	23	47	9	9	88

The size of the bakery was determined primarily on the basis of quantity (fresh weight) of apples utilized during one week. Those using 50 pounds or less were classified as small; 51 to 150 pounds, medium; 151 to 300 pounds, large; and 301 pounds or more, extra large.

Phase II

During November of 1960, supplies of dehydrofrozen apples were distributed to each firm with instructions or assistance in preparation of the test product for pie baking. The supply of apples was distributed proportionately to the number of bakers in each city. Thus, 2,310 pounds of dehydrofrozen apple slices were distributed to cooperators in Baltimore, 3,225 pounds in Philadelphia, and 1,965 pounds in Washington, D. C.

The bakeries were supplied with sample lots of dehydrofrozen apples approximately equivalent to the amount of apple stock normally used during 1 week. Because firms classified as extra large used over 300 pounds weekly, the supply to these firms was limited to the quantity of apple stock used in one day or one 8-hour shift.

In January 1961, after all bakeries had used the dehydrofrozen apple slices, the managers or owners were interviewed to obtain their observations and experiences with the test product.

RESULTS OF THE PRODUCT TESTS--PHASE I

Bakery Characteristics

Weekly Purchase of Fruit

During an average 1-week period, sample bakeries purchased 106,976 pounds of all kinds of fruit. Of this, various forms of apples comprised 55,671 pounds or 52 percent of the aggregate figure. Apple pies were the best sellers among all types of pies handled by bakers, and 95 percent of the bakers interviewed sold apple pies daily. The remaining 48 percent of fruit purchases was spread among many different varieties, and the record-keeping practices of the bakeries did not permit a breakdown of these lesser used fruits.

Quantities of fruit used by respondents varied only slightly from week to week. Bakery owners were asked to compare the quantities used during the week of interview with other weeks during the year. Approximately 60 percent of the respondents said there was no appreciable difference, whereas the other 40 percent were almost equally divided in opinion, saying they either used smaller or larger quantities during other weeks of the year. Some used more fruit during summer months because of availability while others used more during the winter because of the holiday season.

Form of Apples Used

Based on weight, frozen apples were used in the largest quantity--29,597 pounds or about 53 percent of all apples used in the average week. A total of 20,999 pounds or 38 percent of the aggregate quantity of apples used were in fresh form, and 4,402 pounds or 8 percent were canned apples. Dehydrofrozen apples were used in the amount of 673 pounds or 1 percent of total weekly volume. Although table 2 shows that most of the bakers in the 3 cities used canned apples, large firms purchased more of the frozen and fresh apples. Philadelphia bakers, in particular, used large amounts of fresh apples in their open-faced cakes.

Table 2 shows that 54 of the respondents used canned apples, 27 used frozen apples, 39 used fresh apples, and 5 used the dehydrofrozen form. Fifty-six of the respondents used one form of apple exclusively and 32 used various combinations of two or more forms of apples. The forms of apple used most frequently in combinations were fresh and canned apples.

There was a definite relationship between forms of apple used and the size of bakery operation. Bakery men that operated small or medium-sized establishments used mostly canned and fresh apples. Owners of the large and extra-large-sized operations used frozen or fresh apples primarily. Few bakers in the large-sized groups used canned apples, but the majority did maintain a reserve supply.

Table 2.--Form of apple stock used by 88 bakers in 3 test cities

Apple stock	: Baltimore	: Philadelphia	: Washington	: Total, 3 test cities
	: Baker	: Baker	: Baker	: Baker
<u>Canned:</u>				
Uses exclusively.....	13	5	9	27
Uses some <u>1/</u>	5	20	2	27
Total users.....	18	25	11	54
<u>Frozen:</u>				
Uses exclusively.....	4	3	9	16
Uses some <u>1/</u>	4	5	2	11
Total users.....	8	8	11	27
<u>Fresh:</u>				
Uses exclusively.....	3	9	0	12
Uses some <u>1/</u>	3	22	2	27
Total users.....	6	31	2	39
<u>Dehydrofrozen:</u>				
Uses exclusively.....	1	0	0	1
Uses some <u>1/</u>	2	0	2	4
Total users.....	3	0	2	5

1/ Used in combination with other types.

Reasons for Using Various Forms of Apples

When asked their reasons for purchasing a particular form of apple, bakers responded with a total of 169 reasons.

These reasons (table 3) were clearly related and were sorted and summarized under five major categories: (1) Convenience--any form of apple that is easy to use or less trouble than other forms and is easily stored; (2) quality--the form of apple that has a desirable taste or appealing flavor and is of uniform texture and consistency; (3) price--the cost per pound for the particular form of apple is comparable or lower than any other form available; (4) versatility--the form of apple is suitable for all bakery products requiring apples; and (5) customer preference--the form of apple that the baker thought was preferred by his customers.

Convenience and quality were mentioned most frequently by respondents as reasons for using a particular form of apple.

Nearly three-fourths of all reasons by bakers that used canned apples concerned the convenience of this form and only 1 out of 10 reasons related to quality. Conversely, nearly three-fourths of the reasons given by bakers that used frozen apples cited the quality of this form and about 1 in 4 mentioned convenience. Over one-half of the users of fresh apples listed quality as the reason for using and, as would be expected, none of the bakers considered fresh apples as convenient to use as the other forms available.

Table 3.--Reasons given by bakery owners for using various forms of apples

Reason	Canned	Frozen	Fresh	Total, 3 forms
	<u>Replies</u>	<u>Replies</u>	<u>Replies</u>	<u>Replies</u>
Quality.....	8	31	27	66
Convenience.....	57	9	0	66
Price.....	9	1	8	18
Versatility.....	0	0	8	8
Customer preference.....	2	2	2	6
Miscellaneous.....	4	0	1	5
Total replies.....	80	43	46	169

Reasons relating to versatility were given only by the users of fresh apples. Users of canned or frozen apples, especially in the Philadelphia market, told of difficulties they experienced in preparing open-face apple cake and other similar products with canned or frozen apples. No users of fresh apples experienced similar difficulties.

Baker's Knowledge and Use of Dehydrofrozen Apple Slices

During Phase I all bakers were asked if they had ever heard of dehydrofrozen apple slices. Only 29 of the 88 respondents had heard of the product although commercial packs had been available in each test city for as long as 3 years previously. Dehydrofrozen apple slices were new to 59 or approximately 2 out of every three respondents interviewed (table 4).

Respondents located in Philadelphia and Washington were least familiar with the test product. Approximately 70 percent of the respondents interviewed in each of these cities said they had never heard of dehydrofrozen apple slices, while dehydrofrozen apple slices were unknown to 59 percent of the respondents interviewed in Baltimore.

All respondents unfamiliar with dehydrofrozen apple slices were given an explanation about the new product's attributes and then asked if they thought a product of this type could be utilized in their bakery operation. The majority of them considered the product potentially feasible, but also indicated they would like samples to use before evaluating its acceptability to their particular bakery operation.

The 29 respondents who had heard of dehydrofrozen apple slices were asked if they had ever used them in their bakeries. Sixteen had had experience in using these apples at some time previous to the product tests and 11 had never used them. Reluctance on the part of bakeshop employees to change and the unavailability of the product were the reasons most frequently cited by bakers (particularly those in the Philadelphia area) for not using dehydrofrozen apple slices. Price, inconvenient size package, and too much time to prepare were mentioned as other reasons (table 5).

Table 4.--Familiarity of 88 bakers with dehydrofrozen apple slices prior to the product tests, 3 test cities

Test city	Respondents familiarity with the test product			
	Had heard of	Had used	Was current user	Total, all bakers
	<u>Bakers</u>	<u>Bakers</u>	<u>Bakers</u>	<u>Bakers</u>
Baltimore.....	11	10	3	27
Philadelphia.....	12	2	0	40
Washington.....	6	4	2	21
Total.....	29	16	5	88

Table 5.--Reasons given by bakers for not previously using dehydrofrozen apple slices for pie baking, 3 test cities

Reason	Baltimore	Philadelphia	Washington
<u>Bakers</u>	<u>Bakers</u>	<u>Bakers</u>	<u>Bakers</u>
Availability.....	0	3	1
Reluctance to change...	1	3	0
Price.....	0	1	0
Quality.....	0	1	0
Other.....	0	2	1
Total.....	1	10	2

According to one processor of dehydrofrozen apple slices there was more promotional activity by distributors in Baltimore than in the other two test cities. This would explain why 10 of the 11 Baltimore respondents familiar with the test product had used it in their bakery operations at some time prior to the interview, whereas only 4 out of 6 and 2 of the 12 respondents in Washington and Philadelphia, respectively, had used it previously. At the time of interview, only 5 of the 16 respondents were using dehydrofrozen apple slices regularly in their bakery operations.

Nine of the 11 infrequent users said the product was either priced too high, was difficult to prepare, or required a change in established procedures. One respondent said customers had noticed a taste difference in products made with dehydrofrozen apple slices and another gave no explanation. Replies to the question, "Why don't you use dehydrofrozen apple slices regularly in pie baking?" are listed on the following page.

	<u>Number making comment</u>
Price too high	3
Difficult to prepare	3
Prefer other forms	3
Taste different.	1
No reasons given	1
	<u>11</u>

RESULTS OF THE PRODUCT TESTS--PHASE II

After the 88 bakers in Phase II of the study had used the test supplies of dehydro-frozen apples, their reactions to the product were obtained. Questions were asked concerning advantages or disadvantages encountered, appearance of the apples in the end product, and suggestions as to improvement, price, and other pertinent information.

Advantages Found in the Test Product

Approximately 9 in 10 bakers indicated there were advantages in using dehydro-frozen apple slices for pie baking. These advantages were grouped into 5 categories. The majority were classified as convenience or quality. A relatively small number of bakers cited versatility and better moisture control (table 6).

Although the dehydrofrozen product requires the additional step of reconstitution in preparing apples for pie baking, respondents considered convenience the most important advantage. The disposal of empty cans is a problem for bakers using canned and frozen apples. Storage space in freezer cabinets is important to users of frozen apples; and obtaining fresh apples of good quality on a year-round basis, plus the time required in preparing them for use, is important to users of fresh apples.

By packing dehydrofrozen apple slices in cardboard cartons with polyethylene liners, container disposal problems are reduced. These packaging materials are readily disposed of by compressing or burning.

There is an increasing trend by bakery owners to use freezer cabinets as a method of reducing their production and marketing costs. A container of processed dehydrofrozen apple slices requires at least 50 percent less storage space than a conventional 30 pound tin of frozen apples, giving bakers using dehydrofrozen apples the convenience of more freezer space. However, economies associated with freezing bakery products are sometimes offset by the cost of freezer cabinets, emphasizing the need for proper use of available freezer space.

Respondents located in the Philadelphia area cited versatility most frequently as an advantage in using dehydrofrozen apple slices. Many bakers in that area not only make apple pies but also a form of layer cake topped with apple slices. Generally, fresh apple slices are used in making this type of apple cake, but bakers indicated that dehydrofrozen apple slices could be substituted in this particular product or in any bakery product calling for fresh slices.

Table 6.--Advantages of dehydrofrozen apples cited by 79 bakers

Advantage	Number of times cited by bakers	Percent
Convenience.....	98	54
Quality.....	57	31
Versatility.....	13	7
Better moisture control.....	4	2
Miscellaneous.....	10	6
All replies.....	182	100

Disadvantages Found in the Test Product

Bakers were asked if they had experienced any difficulties in preparing dehydrofrozen apple slices for pie baking. Thirty-three experienced no difficulty, but 55 bakers cited problems in preparation procedures. The problems or disadvantages cited are summarized and classified into six general categories (table 7).

Table 7.--Disadvantages of dehydrofrozen apples cited by 55 bakers

Disadvantage	Number of times cited by bakers	Percent
Preparation required additional time or labor.....	34	48.7
Slices too small.....	10	14.3
Difficult to reconstitute.....	8	11.4
Cannot use for all bakery products.....	8	11.4
Inconvenient when compared to canned....	5	7.1
Miscellaneous.....	5	7.1
All replies.....	70	100.0

The most frequently mentioned disadvantage was the additional time and labor required to prepare dehydrofrozen apples for pie baking compared to usual forms of apple stock. Reconstituting accounted for some of this additional time and labor. Other disadvantages mentioned were that there was some difficulty in reconstituting the product, and that dehydrofrozen apple slices could not be used for all bakery products.

Product Characteristics

Bakery operators rely on the attractive appearance of bakery products, sweet goods particularly, for achieving sales--especially impulse sales. Unlike bread, sweet goods are considered by many to be luxury food items and are not consumed regularly. However, many consumers who make regular purchases of bread, are

attracted by the appearance of sweet goods and are sometimes stimulated into making additional purchases. Bakery operators know that consumers often buy because of an attractive appearance and therefore they attempt to improve the appearance of their products.

The 88 cooperating bakers were asked whether they noticed any difference in appearance between the pies baked with usual apple stock and the test product, with the following results:

<u>Dehydrofrozen apple stock compared to--</u>	<u>Noted difference</u>	<u>Noted no difference</u>	<u>Total</u>
Canned	33	10	43
Frozen	13	7	20
Fresh	7	3	10
Various combinations of apple stock	9	4	13
Total	<u>62</u>	<u>24</u>	<u>86</u>

This total is not 88 because one respondent used dehydrofrozen apple slices exclusively and one respondent did not compare.

Approximately two-thirds of the bakery operators contacted reported differences between apple pies baked with dehydrofrozen apple slices and their usual form of apple stock. Proportionately, users of canned apple stock were more apt to note differences in apple pies baked with dehydrofrozen apple slices than did bakery operators who used fresh or frozen apples.

Most of the 62 respondents noticing differences in the appearance of products made with dehydrofrozen apple slices made favorable comments about the dehydrofrozen product. Table 8 lists the reactions of respondents comparing dehydrofrozen apple slices with other forms of apples.

About 3 in 10 of the favorable comments referred to end product appearance. End products made with dehydrofrozen apple slices appeared more attractive than those made with the usual apple stock. Users of canned apples particularly were impressed with the appearance of products made with dehydrofrozen apples. Only a very few unfavorable comments were made. These for the most part came from users of frozen apples. No users of canned apples and only one user of fresh apples considered the appearance of products made with dehydrofrozen apple slices to be unfavorable.

Users of both canned and fresh apples frequently mentioned the discrete slices and lack of mushiness of dehydrofrozen apple products. Apparently, bakery operators have mixed standards in rating the desirable color of any apple stock. Four users of canned apples, two users of frozen, and two who used a combination of apple stock regarded the color of the test product as favorable, whereas three users of canned apples, two users of frozen apples, and one user of a combination of apple stock made unfavorable comments about the color. The most frequently mentioned unfavorable comment was in regard to color, but respondents were not consistent in color dislikes. Approximately equal numbers of respondents regarded the color of dehydrofrozen apple slices as too light or too dark in end products.

A few respondents commented favorable about the uniform slice size of the test product. Others considered the slices too small. Since the processor can usually regulate the slice size, this is not an insoluble detriment to potential market sales.

Table 8.--Reactions of the 62 bakers to pies made with dehydrofrozen apples when compared with pies made from apple stocks 1/

Reaction	When compared with --				Total
	Canned	Frozen	Fresh	Combination	
	<u>Replies</u>	<u>Replies</u>	<u>Replies</u>	<u>Replies</u>	<u>Replies</u>
<u>Favorable:</u>					
Just looked nicer.....	12	3	3	4	22
Slices more distinct.....	12	0	4	1	17
Didn't mush, kept shape better.....	4	2	5	5	16
Better color.....	5	2	0	2	9
Looked like fresh.....	5	0	0	0	5
Slices more uniform.....	1	1	0	0	2
Miscellaneous.....	0	1	0	0	1
Subtotal.....	39	9	12	12	72
<u>Unfavorable:</u>					
Just not as good.....	0	3	1	0	4
Color not as good.....	3	2	1	0	6
Slices too small.....	1	2	0	1	4
Mushy.....	2	1	0	0	3
Miscellaneous.....	1	0	2	0	3
Subtotal.....	7	8	4	1	20
All replies.....	46	17	16	13	92

1/ Sixty-two bakers noted differences in appearance of pies, but differences cited total more than 62 because of multiple answers.

Suggestions For Product Improvement

The cooperating bakers were asked to give suggestions for improving the acceptability of dehydrofrozen apple slices. Thirty-six of the 88 respondents considered the test product to be "excellent" and could give no suggestions for improvement. Most of the suggestions given by the remaining 52 respondents involved marketability, although a few bakers suggested variations or changes in the preparational procedure. The following breakdown of recommendations totals 54 as 2 bakers gave more than one suggestion.

<u>Recommendations to processors</u>	46
Package uniform apple slices--small, medium, and large.	23
Darken--apple slices	4
Improve texture of apple slices.	3
Decrease time needed for reconstituting.	2
Pack with sugar.	2
Pack in smaller units.	2
Lower the price.	2
Print instructions on outer container.	2
Decrease quantity of preservative used	2
Print variety of apple on outer container.	1
Use waxed outer container	1
Use stronger inner bags	1
Eliminate trace of core and seeds	1
<u>Changes in preparational procedure:</u>	8
Add sugar to water before reconstituting.	4
Reconstitute under refrigerated conditions.	2
Use more water.	2
<u>Total.</u>	54

The most frequently mentioned suggestion concerned the slice size of the test product. Twenty-three respondents said they used different sizes of apple slices and preferred that slices be sized and packed accordingly. Bakery operators who used automatic or mechanical pie fillers preferred small apple slices because more consistent fruit counts per pie are obtained. However, respondents who made open-face apple cake preferred large slices for appearance and ease of handling. Dehydrofrozen apple processors might fulfill these specific needs by packing units of varying sizes, but uniform to the package.

Some of the recommendations particularly worth noting were: Placing instructions for reconstituting on the container package; printing the size of slice and variety of apple on the container shell; and enclosing a brochure of recipes utilizing dehydrofrozen apple slices.

One of the specific advantages of dehydrofrozen apple slices is the straight apple pack because freight and storage rates are paid only for apples - a large percentage of the water and all of the sugar being eliminated. A few operators of small bakeries suggested the addition of sugar to commercial packs of dehydrofrozen apple slices. However, this would be a disadvantage for operators of large bakeries as they utilize a high volume of apple stock and can reduce production costs by purchasing bulk sugar and adding it to the dehydrofrozen apple slices in the bakery.

Package Size

Processors of dehydrofrozen apple slices pack them in polyethylene bags and cardboard cartons in units of 15 pounds each. When reconstituted, each 15-pound unit of the product was the equivalent of 30 pounds of apple slices. Respondents cooperating in the study were asked their opinion of the package size in regard to their firm's size of operation.

Data indicate that 74 respondents or 84 percent of the total sample considered the 15-pound package of dehydrofrozen apple slices to be satisfactory for their particular bakery operations. Fourteen of the 88 bakery owners preferred package sizes other than 15 pounds (table 9).

Table 9.--Bakers' opinions of the package size of dehydrofrozen apple slices

Opinion	Responses	Percent
About right.....	74	84
Prefer smaller.....	10	11
Prefer larger.....	4	5
Total.....	88	100

There appears to be a relationship between the size of bakery firm and the size of package desired. Small firms preferred a smaller package of dehydrofrozen apples and large bakeries preferred larger packages. Preferences were also based on the quantity of apples used during one day or week.

Some bakers found the 15-pound unit to be satisfactory because the reconstituted amount of 30 pounds equaled the amount of regularly frozen apples that they usually purchased in one unit. The majority indicated that they generally used about 30 pounds of apples plus 15 pounds of other ingredients for pie baking, which was about the maximum quantity they could prepare at one time. Others indicated that the size of their equipment was a limitation as to the quantity of apples they could prepare or use at one time. Most bakers found the 15-pound unit satisfactory and easy to reconstitute, even in a used "frozen egg" tin container.

Storage and Handling

Frequency of delivery of weekly supplies of frozen apples is shown in table 10. Thirty-eight percent obtained supplies once a week and surprisingly, 62 percent obtained supplies 2 to 3 times per week or as frequently as needed. All respondents who indicated they obtained deliveries "when needed" said it was necessary because they did not own freezers or freezer space available was used for purposes other than storing apples. Generally respondents conducting small or medium bakeries obtained frequent deliveries of apples, whereas, deliveries to large bakeries were generally once a week.

Table 10.--Frequency of delivery of frozen and dehydrofrozen apples

City	Number of users	Frequency per week				When needed
		1	2	3		
Baltimore.....	11	6	0	2		3
Philadelphia.....	8	3	5	0		0
Washington.....	13	3	5	0		5
	<u>1/</u> 32	12	10	2		8

1/ Represents 27 users of frozen and 5 users of dehydrofrozen apple slices.

Two-thirds of the bakers who used frozen apples owned freezers, but only two-thirds of this group used their facilities for storing frozen apples. The remainder considered other uses of existing freezer space more important. Because distributors of frozen apples were generally willing to make frequent deliveries, some respondents used their freezer space for storing baked or unbaked goods.

The use of freezer cabinets as a method of reducing or leveling production costs and gaining additional sales is a growing trend with many bakery operators. Preliminary results of another study indicate that some bakers have successfully demonstrated the utility of freezer facilities by increasing product output while maintaining constant labor costs; increasing gross sales by maintaining inventories of frozen bakery products, thereby, gaining sales normally lost because of unavailability and reducing product losses normally attributed to staleness.

Conservation of storage space is a specific advantage of dehydrofrozen apple slices. They require approximately 50 percent less freezer space than conventionally frozen apple slices. This saving naturally would benefit all bakery operators that use freezer facilities.

Available freezer space among the respondents using frozen apples ranged from 10 cubic feet to 9,000 cubic feet. The space generally used to store frozen apples ranged from 8 cubic feet to 1,400 cubic feet.

Table 11 shows how bakery operators used their freezer space. Comparison of the medians indicates that small and medium-sized bakery operators use approximately 9 percent of existing freezer space for storage of apple stock whereas operators of large or extra-large bakeries use approximately 13 percent.

All bakery owners who stored frozen apples were asked if they could make good use of additional storage space. Slightly less than half indicated that they could use additional space for storing frozen bakery products or frozen fruit. Two respondents said they would like additional freezer facilities but could not expand because of the building size. Generally, respondents with surplus freezer storage space were owners of small or medium-sized bakeries. Normally, owners of large and extra-large bakery operations desired additional freezer space.

Table 11.--Freezer space available for storage of frozen apples by size of bakery

Bakery size	Freezer space			
	Available <u>1/</u>		Used to store apples <u>2/</u>	
	Median	Range	Median	Range
	Cu. Ft.	Cu. Ft.	Cu. Ft.	Cu. Ft.
Small and medium.....	135	10-480	12	8-100
Large and extra large....	2,400	180-9,000	300	12-1,400

1/ Nineteen respondents owned freezers.

2/ Only 12 used their freezer to store apples.

Price

Bakers were asked whether they would purchase dehydrofrozen apple slices on a reconstituted basis, in preference to the usual apple forms, if prices were equal (table 12).

Over 75 percent of the respondents indicated that they would. Five out of 6 users of canned apples; approximately 3 out of 5 users of frozen apples and about 3 out of 4 users of fresh apples were willing to purchase the test product if it were made available within the price range they normally paid for apples.

Respondents were asked what price per pound they paid for apple stock. A wide range in prices was observed.

Prices paid for frozen apples ranged from 12 cents to 20 cents per pound and the average was 16.5 cents. For canned apples, prices ranged from 13.8 cents to 17 cents and the average was 14.6 cents per pound on a gross weight basis, including the weight of the liquid. Respondents who used fresh apples paid an average price of 9.1 cents per pound and indicated only slight variance in the purchase price of fresh apples. The price for fresh apples did not include the costs of preparing them for use. Purchase prices for prepared fresh apples (peeled and sliced) were given by some Philadelphia bakery operators. They indicated a range in price between 11.7 cents and 17 cents per pound and the average price was 15.5 cents per pound (table 13).

Prices paid by bakers for all forms of apples in Philadelphia and Baltimore were relatively equal. The average price paid by Washington bakery operators was slightly higher; approximately 1 cent per pound more for canned apples and .8 cents more for frozen apples.

In order to ascertain whether dehydrofrozen apples could be made available at comparable prices, processors of dehydrofrozen apples and regularly frozen apples were contacted to provide a breakdown of their charges to distributors in the test markets (these charges were nearly identical for each of the three cities) (table 14).

These figures show dehydrofrozen apples could be made available at a savings of 1.4 cents per pound over regularly frozen apples.

Table 12.--Bakery operators' replies to the question whether or not they would be willing to pay the same price per pound for dehydrofrozen apples on a reconstituted basis as normally paid for usual forms of apples

Usual form of apples	Yes	No	Total
	<u>Bakers</u>	<u>Bakers</u>	<u>Bakers</u>
Canned.....	35	7	42
Frozen.....	15	9	24
Fresh.....	14	5	19
Number of bakers.....	64	21	<u>1/</u> 85

1/ Does not total 88, because 2 respondents used dehydrofrozen apples exclusively and 1 respondent did not answer.

Table 13.--Average price per pound paid by users of various forms of apples in 3 test cities

Test cities	Canned <u>1/</u>	Frozen	Fresh	Fresh slices
	<u>Cents</u>	<u>Cents</u>	<u>Cents</u>	<u>Cents</u>
Baltimore, Md.	14.5	16.1	---	---
Philadelphia, Pa.	14.3	16.1	9.1	15.5
Washington, D. C.	15.4	17.0	---	---
Average.....	14.6	16.5	9.1	15.5

1/ The price was computed on the basis of total can contents.

Table 14.--Distributor's average costs per pound of dehydrofrozen and regularly frozen apple slices at the time of product tests

Costs	Dehydrofrozen <u>1/</u>	Frozen
	<u>Cents</u>	<u>Cents</u>
Selling price, f.o.b. processor.....	10.250	11.000
Storage for 6 months.....	.520	.850
Transportation.....	.362	.725
Total cost to distributors.....	11.132	12.575

1/ On a reconstituted basis.

On the basis of data supplied by processors and assuming equal markups, dehydrofrozen apple slices could be marketed at prices cheaper than some forms and comparable to that of others. Therefore, it appears entirely reasonable that the condition of comparable price can be met. Table 15 indicates various local market margin possibilities in pricing dehydrofrozen apple slices relative to other products.

Table 15.--Markup available to a distributor of dehydrofrozen apple slices meeting the current price of other apple types

Apple type	Current price <u>1/</u>	Distributor's possible markup			
		Dollar markup	Markup on selling price	Markup on cost <u>2/</u>	
	<u>Cents</u>	<u>Cents</u>	<u>Percent</u>	<u>Percent</u>	
Frozen.....	16.5	5.368	32.5	48.2	
Fresh slices.....	15.5	4.368	28.2	39.2	
Canned.....	14.6	3.468	23.8	31.2	

1/ Average prices paid per pound of product by cooperating bakers.

2/ Based on a distributor's cost of 11.132 per pound.

Based on the average prices paid by bakers for the three forms of apples and a cost per pound of 11.1 cents for dehydrofrozen apple slices, a distributor could obtain a margin of 24 percent (31 percent if he calculated his markup on cost) even if he met the average price of canned apples--the lowest in price of the related products.

Bakers' Willingness or Unwillingness to Purchase at Equivalent Prices

Bakers were asked to give reasons for their unwillingness to buy dehydrofrozen apple slices if the product were available at an equivalent price with the apple form usually bought. Most bakers were willing to purchase dehydrofrozen apple slices at the equivalent price, but their reasons for doing so varied. Users of canned apples preferred dehydrofrozen apple slices because of taste or flavor and versatility; users of frozen apples because of easier handling and storage; and users of fresh apples because of uniform color and texture, and the time and labor-saving features of the test product (table 16).

Taste and flavor were the most frequently mentioned reasons. Most of the users of canned apples gave taste or flavor as the reason for preferring the test product. However, no user of fresh apples considered the taste or flavor of dehydrofrozen apples as superior to fresh.

The relatively few reasons given by bakers for preferring the usual form of apple over the test product were that fresh apple slices were more versatile, frozen had a better flavor, and that canned didn't require frozen storage space and were more convenient (table 17).

Table 16.--Reasons why 64 bakers would be willing to pay the equivalent prices of usual forms of apples for similar quantities of reconstituted dehydrofrozen apples

Reason <u>1</u> /	Canned	Frozen	Fresh	Total, 3 forms
	<u>Replies</u>	<u>Replies</u>	<u>Replies</u>	<u>Replies</u>
Taste or flavor.....	28	3	0	31
Can use in all bakery products..	9	3	0	12
Texture, color, more uniform...	2	1	7	10
Easier to handle and store.....	2	5	1	8
Better quality.....	6	0	1	7
Straight apple pack.....	2	2	2	6
Time or labor saving.....	0	0	5	5
More convenient.....	1	1	1	3
Customers preferred.....	1	1	0	2
Does not spoil.....	0	0	2	2
Miscellaneous.....	0	2	1	3
All replies.....	51	18	20	89

1/ Reasons total more than 64 because of multiple answers.

Table 17.--Reasons why 21 bakers would not be willing to pay the equivalent prices of usual forms of apples for similar quantities of reconstituted dehydrofrozen apples

Reason <u>1</u> /	Canned	Frozen	Fresh	Total, 3 forms
	<u>Replies</u>	<u>Replies</u>	<u>Replies</u>	<u>Replies</u>
Inconvenient.....	2	2	2	6
Flavor, taste not as good.....	1	4	0	5
Price too high.....	1	1	1	3
Cannot use in all products.....	0	0	3	3
Requires freezer space.....	2	0	0	2
Miscellaneous.....	4	1	1	6
All replies.....	10	8	7	25

1/ Reasons total more than 21 because of multiple answers.

CONCLUSION

The commercial possibilities of the test product appear to be excellent. The baker's reactions were generally favorable and the large and extra-large institutional and wholesale bakers were especially complimentary. The product apparently will fit best into the operations of these large users where the obvious economies of handling and distribution are a definite and substantial saving.

Although customers of the bakers were not interviewed, some bakers reported having received favorable comments from customers regarding dehydrofrozen apples.

Although there was only one commercial processor of dehydrofrozen apple slices when the study was first initiated, today there are least eight, and others are investigating the possibilities. Since the inception of the study several large regional and national grocery chains have adopted dehydrofrozen apple slices for their pie baking.

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